# THE CRUSHED STONE JOURNAL

*Official Publication*
The National Crushed Stone Association

## *In This Issue—*



MAY, 1929

# WHY HAVE LOSSES

## Poor Grading—High Overhead—Troubles

**Ask the following stone producers why they are using NIAGARA ROLLER BEARING SCREENS year after year**

| | |
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| Rock-Cut Stone Company | Jamesville, N. Y. |
| Rock-Cut Stone Company | Lacona, N. Y. |
| Rock-Cut Stone Company | Watertown, N. Y. |
| Mohawk Limestone Products Company | Mohawk, N. Y. |
| Mohawk Limestone Products Company | Jordanville, N. Y. |
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| J. E. Baker Company | White Hall, Baltimore, Md. |
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| Dufferin Construction Company | Innerkip, Ont. |
| Gordon Crushed Stone Company | Hagersville, Ont. |
| Thomas Langton Crushed Stone | Coldwater, Ont. |
| LaCle A. Desrosiers, Ltd. | Montreal, Que. |
| Puslinch Quarries, Ltd. | Puslinch, Ont. |
| Quinn Stone and Ore Company | Ft. William, Ont. |
| Rigand Granite Products Company | Rigand, Que. |
| Stone and Son | Ingersoll, Ont. |
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# Utilization of Crushed Stone in Low Cost Roads

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*Director, Bureau of Engineering, National Crushed Stone Association*

DIGEST

Secondary highways form the bulk of the highway mileage of the country and some 2,000,000 miles of such highways are at present unsurfaced. The traffic on these roads will, for the most part be of low intensity for which low type roads will be adequate and economical. Some will carry heavier traffic, thus justifying better and more expensive surfaces and still others will approach the primary system in importance and ultimately will become a part of the primary system. On these, high types of surfaces should be used.

Roads should be improved gradually or in successive stages to suit the traffic needs and crushed stone lends itself admirably to this process of "stage construction." The present article describes some of the principal types of crushed stone roads and gives useful data on size of material, costs and the traffic conditions under which these types should be used. A tabular summary of this information is given on the following page.

STATE and other highway building agencies are beginning to devote more of their attention to the building up of the secondary highways which feed their primary systems. Such highways form by far the bulk of the highway mileage. Thus, it is estimated that the total road mileage in the United States on January 1, 1929, was 3,016,874 and of this mileage 300,929 miles were included in the state systems. There probably are close to 500,000 miles of surfaced local roads so that fully 2,000,000 miles of highways remain unsurfaced.

Many of these local or secondary roads will never require any surfacing whatever, either because of their naturally satisfactory condition or because their traffic does not total more than a few vehicles per day. Other roads in this great secondary system will need high types of surfacing for they will develop into heavily traveled highways of primary importance. Between these extremes there will be roads carrying traffic ranging from a few vehicles up to 1,000 or 2,000 vehicles per day.

Suppose it were erroneously decided that a proper plan of procedure in the building of the secondary roads required the surfacing of all of these 2,000,000 miles of highways with an average high-class surface costing $20,000 per mile. The total cost for construction alone, with no provision for maintenance would be $40,000,000,000. This would be a tremendous expense and the time required for the completion of this great secondary system would be approximately forty years at our present rate of expenditure for highways. Under such a plan, some communities would be without roads for a period of forty years. Moreover, many of these roads would have a too expensive surface for the traffic carried and some would be inadequate.

## Stage Construction

Under a more suitable plan of road improvement, that of adapting the road type to the particular conditions of traffic and nature, a large percentage of the mileage could be built in a comparatively short time, at relatively little expense; the whole country would receive almost immediate benefit and as traffic demands increased so also could the roads be correspondingly improved.

Such a system would include a large mileage of roads, merely graded and drained, a large mileage having only a thin treatment of hard surfacing material; still other roads would be surface treated with bituminous or non-bituminous material to render them dustless and more adequate for their traffic and, finally, another group would require greater thickness and a well developed bituminous bound surface. Certain of these roads may finally have to be covered with the highest types of surfacing known, for they will have developed a primary road intensity of traffic. Under this system of road improvement the surface is suited

**Summary of Data on Low Cost Roads Utilizing Crushed Stone**

| Type | Thickness | Traffic Capacity | Initial Cost | Maintenance | Size of Material |
|---|---|---|---|---|---|
| Traffic-Bound | Varies from 1-3 in. after first year. 5-6 in. after several years. | 300 to 600 per day including light 2½ ton trucks, infrequent 5 & 7 ton trucks except in spring of year. | $2000 to $3000 | $1000 the 2nd year $500 per yr. thereafter. | Passing<br>1"................100%<br>¼"..............0—10%<br>No. 10..........0—10% |
| Traffic-Bound Roads Mixed-in-Place Surface | 1½ to 3 in. | 800 to 1500 vehicles per day. | $1100 to $3000 | $400 to $900 | ¾ to 1¼ in. |
| Water Bound Macadam | 4 to 6 inches compacted for each course. Total thickness 6 to 12 inches. | 500 to 800 vehicles per day including light and heavier trucks if of sufficient thickness. | $8000 to $20,000 | $300 to $600 | Soft Stone: 2½ to 4"; 0 to ¾"<br>Hard Stone: 1¼ to 2½"; ¾ to 1¼"; 0 to ¾" |
| Single Surface Treated Macadam | Above described Water-bound Macadam surface treated ¼ to ½ in. penetration. | 800 to 1000 and more under favorable conditions. | $300 to $500 per mile of 18 ft. width for single treatment. | $200 to $500 per mile of 18 ft. width over 5 or 6 year period. | Cover for cold application. ¼ to ½ or ¾" chips. |
| Dual Surface Treated Macadam | ½ to 1" penetration | 700 to 2000 per day and more under favorable conditions. | $1100 to $3000 per mile of 18 ft. width. | $200 to $500 Including scarifying & retreatments $1000 per year. | Cover for hot application ¼ to ¾ or 1¼" stone. |
| Mixed-in-Place Bituminous Surface (Retread) | 1½ to 3" | 800 to 2000 vehicles per day and more under favorable conditions. | $2000 to $4500 | $300 to $700 | ¾ to 1¼" material<br>Passing<br>1½" ................100%<br>1" ...............25—75%<br>¾" ..................0—15% |
| Bituminous Macadam | 2½ to 3½" surface on Macadam base courses. | 1000 to 2000 and more—foundation strength controls weight capacity. | $9000 to $17,000 for 3 in. depth, 18 ft. width | $150 to $600 $350 per year on an average. | Soft Stone: 2½—3½"; ¾—1½"; ½—⅞"<br>Hard Stone: 1½—2½"; ⅝—1"; ⅜—⅝" |
| Bituminous Concrete on Bit. Conc., Bit. Macadam or Stone Base. | 2 to 4 inches. | 1000 to 2000 and more under favorable conditions. | $10,000 to $25,000 | $150 to $300 | ¼—⅝" or ¾"<br>¼—1¼" or 1½"<br>¼—2" or 2½" |

to the traffic which it is anticipated the road will carry in the immediate future and under this system the surfacing is improved to a still higher type as the traffic increases and warrants additional road expenditures. Such a system of procedure is the plan of so-called "stage construction" and it lends itself admirably to the rapid development of secondary roads.

In the building of roads by the "stage construction" method, crushed stone will play a vital part, for it is an ideal material for all types of secondary highways as well as for those in the primary highway systems.

## Classification of Low Cost Highways Utilizing Crushed Stone

Crushed stone is used in the following types of low cost roads:

1. Traffic bound roads
2. Waterbound macadam
3. Surface treated traffic bound roads
4. Surface treated macadam
5. Bituminous macadam
6. Bituminous concretes of several types.

## Essential Features of the Above Types

An excellent bulletin has been published on "Low Cost Improved Roads" by C. N. Conner, Chief Engineer, American Road Builders' Association, Washington, D. C. This bulletin is Part II of the Proceedings of the Seventh Annual Meeting of the Highway Research Board.

His data was gathered by personal experience, by observation throughout the United States and through the collaboration of various individuals and agencies. Much of the data for the present article was obtained from Mr. Conner's bulletin and in part also from other sources. It is arranged primarily to show how crushed stone may best be used in secondary highway construction. Mr. Conner's bulletin describes the use of material other than crushed stone.

## Crushed Stone Traffic-Bound Roads[1]

### Digest of Essential Data

*Thickness*: Varies from 1 to 3 inches after first year, 5 to 6 inches after several years.

| | | |
|---|---|---|
| *Size of Stone*: | Passing 1 in. | 100% |
| | " 1/4 in. | 0 to 10% |
| | " No. 10 | 0 to 10% |

*Traffic Capacity*: 300 to 600 vehicles per day, including light 2½ ton trucks, infrequent 5 and 7 ton trucks except when subgrade is soft.

*Initial Cost*: $2,000 to $3,000.

*Maintenance*: $1,000 the second year, $500 per year thereafter.

### General Description

This type of surfacing consists of small size crushed stone spread in a thin layer over the new subgrade or other road surface by the use of a suitable drag or blade. Before the stone is applied to a new subgrade, due care should be exercised to see that the alignment and grade are suitable for high speed traffic, for traffic-bound roads are exceptionally smooth because of the dragging process and they invite high speeds. Drainage should be properly cared for because the traffic-bound road is apt to be merely the initial stage in the final construction of a very much better type of surfacing which will be built when traffic increases sufficiently.

If the proper grade and alignment are built into the road initially and the drainage adequately cared for, very little change will be needed to convert the road of low type into one of the highest type, whereas if these features are neglected considerable expense will be involved and much of the foundation value of the traffic-bound road will be lost. The compaction of stone under traffic is very much greater than can be obtained through the use of a heavy roller because traffic compacts the stone in thin layers progressively upward from the subgrade. Moreover, traffic will discover the weak spots in the subgrade and such spots will almost automatically be cured by the maintenance measures used.

The cross-section of the traffic-bound road should show a rather flat crown not exceeding 3/8 inch per foot and it is desirable that the wearing surface be as wide as practicable and preferably not narrower than 20 feet, for it is necessary that the traffic be distributed over the width of the road so as not to run in tracks. The desired lateral distribution of traffic is encouraged when the surfacing is of adequate width.

[1] See also, "Low Cost Improvement of Earth Roads with Crushed Stone," Bulletin No. 2, The National Crushed Stone Association.

### Construction Methods

After the subgrade has been prepared, the surfacing material is spread at the rate of approximately 1,000 tons per mile for the first application. The size and kind of material varies in different localities and the best results are secured with an initial application of crushed stone passing a 1-inch screen and retained on a No. 10 sieve. After the stone is spread from dump trucks, it is bladed to the sides of the road in windrows, leaving a layer only one inch thick on the subgrade. Traffic is immediately turned on the road and as the weak spots develop, additional stone is dragged in from the windrows or piles along the sides, and in this manner the weak spots are kept filled and the stone surfacing becomes thoroughly compacted under traffic.

A smooth surface is maintained by dragging and additional material is drawn in from the sides as required. The ideal condition exists when a thin, loose layer of stone lies on the surface and for this reason it is undesirable that the stone contain any clay or material which will cause it to bond tightly together. The presence of clay will likewise be disadvantageous when the time arrives for giving the road a bituminous surface treatment. Stone containing excess clay cannot be dragged successfully and, moreover, the surface develops pot-holes. If the layer of loose stone becomes too thick, it is dangerous for traffic. Less than one inch of uncompacted material is desirable as a surface layer. In time, as more and more stone compacts and the loose material is drawn in from the sides, the road crust gradually builds up in thickness and becomes more and more efficient for carrying loads. At the end of the first year, as the result of the constant dragging in of new material, there generally results a compacted surface 2 to 3 inches in depth.

### Maintenance Methods

The methods of maintaining a traffic-bound road are similar to the original construction methods. New crushed stone is stock piled along the road or is placed in windrows at the sides. Generally, when the road surface is wet, additional stone is dragged in from the sides by the use of one-man patrol graders and occasionally the surface is planed with heavier equipment. Should breaks occur in the surface during a period of soft subgrade, they should be repaired immediately.

### Construction Costs

The cost of construction depends largely upon the cost of materials but the first year's cost should not exceed $3,000.

### Maintenance Costs

The cost of materials and dragging the road will be in the neighborhood of $1,000 during the second year and approximately $500 during the third year.

### Service Value

Traffic bound roads are suitable for traffic up to 300 to 600 vehicles per day consisting largely of automobiles, some 2½ ton trucks and infrequent 5 and 7 ton trucks. In view of the dragging operations, a traffic-bound surface is unusually smooth and high speeds are the rule. When dust becomes a nuisance, owing to increased traffic, such roads may be surface treated with bituminous material or with non-bituminous surface treatments such as calcium chloride. Such treatments are said to double the traffic capacity.

## Crushed Stone Water-Bound Macadam

### Digest of Essential Data

*Thickness*: 4 to 6 inches, compacted, for each coarse. Total thickness may vary from 6 to 12 inches.

*Size of Stone*: For hard stone, with a percentage of wear less than 4.0, the three sizes used are: 1¼ to 2½ in., ¾ to 1¼ in. and screenings, all passing ¾ in. For softer stone having a percentage of wear varying from 4 to 8, use the following sizes:

| | |
|---|---|
| Large size—Passing 4 in. | 95 to 100% |
| " 2½ in. | 0 to 10% |
| Screenings—Passing ¾ in. | 95 to 100% |
| " ¼ in. | 30 to 60% |
| " No. 100 sieve | 5 to 20% |

*Traffic Capacity*: 500 to 800 vehicles per day, including light trucks and heavier trucks if surfacing is of sufficient thickness.

*Initial Cost*: $8,000 to $20,000 per mile.

*Maintenance*: $300 to $600 per year.

### General Description

The crushed stone water-bound macadam road is one of the oldest types of crushed stone roads. Generally, it is built in one or more courses of broken stone of comparatively large, uniform size with the voids filled with finer material, such as stone screenings. Compaction is obtained by rolling with a heavy roller and water is sometimes used to assist in the void-filling and binding process.

### Construction Methods

In the construction of water-bound macadam the stone in the base course is sometimes allowed to be of a softer quality than in the surface course, in which case, however, it is essential to use rather large sizes, sometimes extending up to 5½ inches in diameter. The following construction procedure is usually practiced: A trench section is made to receive the stone and wood side forms may be used to gauge the loose depth of the stone. The stone is preferably spread from spreading devices attached to the motor truck. Such devices insure uniformity of depth and aid in producing uniformity of subsequent compaction. The compacted depth seldom exceeds the greatest diameter of stone by more than ½ inch. The average depth of the compacted layer is 4 inches, although 6-inch compacted layers are sometimes used. Earth from the shoulders is placed to prevent the lateral spreading of the stone during the rolling operation. Construction is carried on with the following procedure:

1. Hauling and spreading the layer of coarse stone. The stone should never be dumped directly on the subgrade or base course in piles.
2. Shaping the loose layer of stone by hand tools, sometimes harrowing and blading it.
3. Rolling with 10 ton power rollers usually of a 3-wheel type.
4. Spreading fine stone, screenings or other suitable fillers. These are spread evenly and gradually over the surface.
5. Rolling is continued, usually on the dry surface.
6. Watering, the addition of more screenings or filler and protracted rolling are continued until a fine grout appears on the surface and applied water runs to the edges of the surface. The rolling operation is started at the sides of the road with the roller wheel overlapping on the shoulder and the rolling progresses toward the center.

### Maintenance Methods

Water-bound macadam at one time was a very suitable road for steel tired traffic. Now, without a bituminous or other surface treatment, or without constant maintenance, it ravels and develops pot-holes because of the removal of the binder by present-day, fast moving, rubber-tired traffic. Consequently, it becomes necessary to maintain water-bound macadam surfaces by several available means.

One method consists of retaining a thin layer of small size stone constantly on the surface; dragging it at sufficiently frequent intervals to keep it in a smooth condition and adding new material as this becomes necessary. This is the traffic-bound method of maintenance. Still other methods call for the use of calcium chloride to keep down the dust and thus help to prevent the surface from raveling and bituminous surface treatments are also frequently used to help bind the surface together and to prevent dust from forming. This method, which calls for the use of a cover material, frequently of clean stone screenings, will be described.

### Single Surface Treated Macadam

The single surface treatment is intended to build up a comparatively thin mat which will need renewal at yearly intervals or more frequently. It is practiced with success on roads capable of 600 to 800 vehicles per day. Two methods are used, one requiring a prime coat of light bitumen and the other without a prime coat.

### Method I—With Prime Coat

The surface is swept clean but care is taken not to loosen the aggregate. Light cold tar or cold asphaltic oil is applied at the rate of 1/6 to 1/4 gal. per sq. yd. Then, in 2 to 24 hours a heavier bitumen is applied cold or moderately warm at the rate of 0.2 to 0.4 gal. per sq. yd. Cover material in amounts from 20 to 50 lbs. per sq. yd. is used, depending on the condition of the bituminous material. Asphaltic oils require more cover than tars and to prevent a nuisance from excess bitumen, city streets require more cover than country highways.

### Method II—Without Prime Coat

In this method the clean, dry surface is treated with a single application of tar or asphalt applied hot or cold. The rate of application is from 0.2 to 0.6 gal. per sq. yd. with cover material applied at the rate of 10 to 40 lb. per sq. yd. If stone is used for cover material it should be in the form of ¼ to ½ or ¾ in. chips. Stone makes an excellent cover material because of the stability of the resulting mat and its tendency to stay on the road surface. Its uniformity and angularity are both very desirable properties.

## Dual Surface Treated Water Bound Macadam

### Digest of Essential Data

*Thickness*: ½ in. to 1 inch of treated material.

*Size of Stone*: ¼ in. to ½ in. chips for lightest bituminous treatments and ¼ to ¾ or 1¼ in. for the heavier treatments.

*Traffic Capacity*: 700 to 2,000 vehicles per day.

*Initial Cost*: $1,100 to $3,000 per mile.

*Maintenance Cost*: $200 to $1,200 per year.

### General Description

The dual surface treatment is suitable for macadam roads whose surface is regular and free from loose material. There is a wide variation in the methods of construction and classes of bituminous materials used. Generally, however, the method involves the use of a prime coat of light bitumen followed later by the second application of bitumen covered with stone chips and rolled.

### Materials

For the prime coat either cold liquid tar, cut-back asphalt, or low viscosity road oil is used. A second prime coat, if necessary, is given of the same material. The final coat is usually a heavy bitumen such as hot asphalt, hot tar, or a cold cut-back asphalt or heavy road oil. If the prime coat is given any cover treatment at all, this usually consists of a light scattering of clean, coarse sand. With the lighter bituminous materials small chips are used as cover material and the large chips, ¼ to ¾ in., and sometimes up to 1¼ in., are used with the heavier bitumens.

### Construction Methods

The untreated surface is first thoroughly prepared for treatment by sweeping with power brooms. The road may be closed to traffic or it may be treated one-half at a time. The methods used are as follows:

1. A prime coat of bitumen is given at the rate of 0.2 to 0.3 gal. per sq. yd. No cover material is applied, as a rule, unless necessary to prevent flowing. The prime coat is allowed to penetrate from several hours up to two weeks.

2. A second application of bitumen is applied from a power distributor at the rate of 0.3 to 0.4 gal. per sq. yd.

3. Cover material is immediately spread on the second application, preferably by the use of spreading

devices attached to a truck. If the bitumen is heavy and the material applied hot, large stone chips, ¼ to ¾ in. are spread at the rate of 35 pounds to 50 pounds per sq. yd. Lighter materials require the use of smaller chips.

4. The coarse chips are evenly spread by brooms and at once rolled with a power roller. If the bitumen is a light oil or cut-back, the surface is usually dragged to an even contour.

5. A seal coat may or may not be applied at once or during a succeeding season. If the surface appears open or inclined to ravel a cold or hot seal coat may be necessary at the rate of 1/6 to 1/5 gal. per sq. yd. with a coarse sand cover.

### Maintenance Methods

If any deep holes form, they are patched with premixed aggregates and bitumen. Small breaks and ravelling are corrected by the application of bitumen and cover material. If there is general surface breakage or irregular surface over a considerable area the entire surface treatment should be lightly scarified. The broken up surface is then disk harrowed, spread with a road blade and rolled; finally retreated with bituminous material, followed by stone chips.

### Construction Costs

The initial construction of prime coat and second coat and cover varies from $1,100 to $3,000 per mile for an 18 ft. width depending upon local conditions and the class of materials used.

### Maintenance Costs

Such items as scarifying and re-treatments will greatly affect the annual maintenance costs. Without these two items it amounts to from $200 to $500 per mile. With treatments, with or without scarifying, maintenance of the surface ranges from $800 to $1,200 per mile, with an average over a period of years of $1,000 and less.

### Service

The service range depends largely on the type of base and varies from 700 to 2,000 vehicles per day or more. Maintenance costs increase with the volume of traffic, but 1,000 vehicles per day does not exceed the capacity of dual surface treatments on substantial bases.

## Mixed in Place Bituminous Surfaces [2]

### Digest of Essential Data

*Thickness*: 1½ to 3 inches of mixed surface.

*Size of Stone*: ¾ to 1¼ in.

| | | |
|---|---|---|
| Passing | 1½ in. | 100% |
| " | 1¼ in. | 95 to 100% |
| " | 1 in. | 25 to 75% |
| " | ¾ in. | 0 to 15% |

*Traffic Capacity*: 800 to 2,000 vehicles per day.

*Cost*: $2,000 to $4,500 per mile.

*Maintenance*: $300 to $700 per year.

### General Description

The mixed-in-place bituminous surface, which is also known as oil-bound broken stone surface, carpet treatment and "Retread" was developed as a surfacing which would be of intermediate value between that offered by a dual surface treatment and bituminous macadam. This is not regarded as being quite as good a surface as bituminous macadam but has been used with surprisingly good results on well compacted bases and is very suitable for use on water-bound macadam or well compacted traffic-bound roads. The mixed-in-place method consists essentially of the spreading of a thin layer of stone followed by the application of bitumen from a power distributor, blading until the surface begins to set, the application of lighter amount of bitumen after several days followed by a cover of stone chips, preferably followed by rolling.

### Methods of Construction

The sequence of the methods of construction are as follows:

1. Scarify and shape old base, adding additional stone if necessary or merely sweeping the base clean of dust and dirt if it is already of proper cross-section, graded and well solidified.

2. Spread layer of loose stone to such depth that when compacted it will be 2 inches in thickness.

3. Make first application of bitumen at the rate of 0.5 to 0.75 gal. per sq. yd.

4. Blade surface to proper cross-section.

5. Continue blading to maintain desired cross-section until surface begins to set.

[2] See also, "Retreading Our Highways," Bulletin No. 4, The National Crushed Stone Association.

6. At the end of 4 or 5 days, after the surface has set, apply about 0.25 gal. of bitumen followed by a light cover of stone chips. Traffic is permitted to operate during the entire construction.

Rolling with a 5 to 10 ton roller is desirable. The rolling may follow immediately after the first application and blading.

Rolling of the seal coat is also effective in securing quick compaction and reducing loss of chips.

There are many variations in the method of constructing mixed-in-place bituminous surface and the methods used may have to be varied somewhat from those described, depending upon the local materials used.

## The Bituminous Macadam Pavement

### Digest of Essential Data

*Thickness*: Surface Course, 2½ to 3½ inches.
Base Course, 3 to 4 inches.
Foundation Course, 4 to 6 inches and more.

*Size of Stone*: When the per cent of wear is less than 4.0.

*Surface Course*:

Coarse stone—1½ to 2½ in. or 1¾ to 3 in.

Keystone—⅝ to 1 in. for 1½ to 2½ in. coarse stone.

Cover stone—⅜ to ⅝ in. or ¾ in.

When the per cent of wear is between 4.0 and 6.0—

Coarse stone—2½ to 3½ in. or 2½ to 4 in.

Keystone—¾ to 1½ in.

Cover stone—½ to ⅞ in.

*Traffic Capacity*: 1,000 to 2,000 vehicles per day and more. The strength of the foundation controls the weight of vehicles permissible.

*Initial Cost*: $9,000 to $17,000 for a 3-inch depth of surface course, 18 feet wide.

*Maintenance Cost*: $150 to $600 per year, $350 per year is an average figure.

### General Description

The bituminous macadam pavement consists of crushed stone and bituminous material incorporated together by penetration methods. It is an excellent type of surface when well constructed on a strong foundation. It should not be built unless the foundation and base courses are capable of sustaining heavy truck loads. The foundation course may consist of hand-placed stone, crushed stone, gravel or old macadam compacted under traffic. The crushed stone base course should be well rolled and filled as in the case of water-bound macadam, although water-binding is not always used for the base course.

The surface course consists merely of a layer of uniformly compacted stone, rolled sufficiently to properly key it together and the voids are then filled with bituminous material distributed over the surface from a pressure distributor. Choke stone is then applied and rolled and finally one or more seal coats of bitumen is applied and each is given a cover coat of stone chips. Finally, in addition to intermediate rolling, the finished surface is thoroughly rolled for a period of 4 or 5 days during the warm part of the day when the rolling is most effective.

### Construction Procedure

Because of the differences in hardness of rock in various sections of the country, somewhat different construction details have been developed, each best suited for particular classes of materials. Thus, in the New England states, where the harder traps are available, the methods are different from in the middle Western section of the country where the softer limestones are found. Of the two following methods, Method I is best suited to the trap rocks and rocks of harder variety and Method II to the softer stones.

### Method I—Double Penetration Method

The following steps are carried out in this method:

1. The coarse stone 1½-2½ in. or 1¾-3 in. is spread uniformly between headers on the base course to the proper depth. A compacted thickness of 2½ to 3 in. is desirable.
2. Coarse stone is thoroughly rolled and compacted with a 10 to 12 ton roller.
3. Bitumen is applied uniformly with pressure distributor at the rate of 1¾ gal. per sq. yd., if 1½-2½ in. stone is used; and 2 gal. per sq. yd., if 1¾-3 in. stone is used.
4. Keystone, ⅝-1 in.[3] for 1½-2½ in. coarse stone and ¾-1¼ in. for 1¾-3 in. coarse stone, is applied to

[3] Note: This size is best adapted to asphalt binder. Better results are said to be obtained when a smaller size (⅜-½ in.) is used with tar binder.

the amount of one ton per 40 sq. yds. of surface when hard stone is used. This should be reduced when soft stone is employed.

5. Surface is thoroughly rolled to force keystone into surface voids and produce tightly compacted surface.
6. Second application of bituminous binder is given at the rate of ¾ gal. per sq. yd. with hard stone and ½ gal. with softer stone cover.
7. Cover stone (⅜-⅝ in. or ⅜-¾ in.) in size to the amount of one ton for 55 to 70 sq. yds., the latter figure for cover applied in late fall. The larger size is for use with larger size coarse stone.

The above method is particularly applicable to bituminous macadam constructed with the hardest varieties of stone.

### Method II—Triple Penetration Method

The following is usually referred to as a double seal coat method. It is most used with the softer varieties of stone.

1. Spread stone, 2½-3½ in. or 2½-4 in. in size, uniformly to proper depth between header boards and using spreading devices.
2. Roll and thoroughly compact stone with 10 to 12-ton roller. Over-rolling which crushes stone should be avoided and shattered stone spots should be replaced and recompacted. A compacted thickness of 3 inches is desirable.
3. Apply bitumen with pressure distributor at the rate of 1.5 gal. per sq. yd.
4. Apply ¾-1½ in. coarse covering or choke stone at the rate of 1 cu. yd. to 250 sq. yd. of surface (1 ton per 194 sq. yd.)
5. Roll before bituminous material hardens and continue rolling until solid compact mass results.
6. A small amount of fine cover material (½-⅞ in.) should be swept over the surface to loosely fill surface voids.
7. Apply second application of bituminous material at the rate of 0.5 gal. per sq. yd.
8. Broadcast just sufficient fine cover over the surface to prevent roller wheels from sticking.
9. Roll surface to thoroughly compact it. Roller should be used on at least 5 days when the bitumen is soft. Additional fine cover should be applied sparingly as required during the rolling. Total amount should not exceed 1 cu. yd. to 240 sq. yds. of surface (1 ton for 200 sq. yd.)
10. Any voids left in top should be filled by brooming fine covering material over surface and surplus should be swept off.
11. Apply third treatment of bituminous material at the rate of 1/3 gal. per sq. yd.
12. Cover with fine cover material at the rate of one cu. yd. to 120 sq. yd. of surface (one ton per 100 sq. yd.)
13. If heavy bituminous material has been used in the third application, the surface should be rolled after the application of fine cover.

The strictest attention to every detail of construction is essential to the success of a bituminous macadam surface course. *This point is again emphasized for it is too frequently overlooked and greatly inferior inspection is too often the rule.*

### Construction Methods

Before constructing the surface course, the base course should be checked to determine its degree of smoothness. There should be no spots having a depression greater than ⅜ in. in 18 feet. Such spots should be loosened, additional stone applied and rerolled.

In the construction of bituminous macadam it is highly important that the surface course have a uniform texture before the application of the bitumen and to accomplish this result the gradation of the stone must be constantly uniform and if there is any soft stone present which crushes under the roller such stone must be removed and stone replaced with harder material before applying the bituminous cement. The surface should be checked by means of a template to determine its smoothness and low spots should be corrected in the manner above described for correcting the base course. A transverse strike board, supported on headers should be used to check the cross-section.

The stability of a bituminous macadam course depends very largely on the mechanical bond and the interlocking effect of the stone and for this reason it is highly important that sufficient rolling be given the stone before any bitumen is applied. On the other hand, the stone should not be excessively rolled so that there will be crushing under the roller with a conse-

quent clogging of the surface voids. This will prevent proper penetration of the bitumen and subsequent surface defects will develop.

Rolling is generally carried out with a 10 ton roller of the 3-wheel type, starting at the sides with one wheel resting partially on the shoulder. The rolling progresses gradually toward the center, each passage of the roller overlapping, to some extent, the path of the previous passage.

After thorough compaction of the stone, which occurs when there is no movement under the roller, the bituminous binder is applied. At this time the stone should be dry and the atmosphere preferably above 65°F. with no freezing weather in sight. The bitumen is applied from a pressure distributor in which at least 25 lb. per sq. in. pressure is maintained. Care is taken to see that the bitumen is applied with great uniformity and numerous expedients are used to accomplish this purpose which are treated in detail elsewhere. (See The Bituminous Macadam Pavement, Bulletin No. 6, of The National Crushed Stone Association).

### Keystone or Choke Stone

Immediately after the first coat of bitumen has been applied keystone or choke stone, which has been properly stock-piled along the sides of the road before the coarse stone has been spread, is broadcast over the surface to the proper amount. The purpose of the keystone is to fill the voids between the coarse stone and to wedge the surface tightly together. It is not the purpose of the keystone to provide an extra layer on top of the stone. Accordingly, the keystone must be of just the right size to fit into the voids in the coarse stone and it must be distributed in just the right amount. After broadcasting the keystone, it is rolled before the bituminous material hardens to such an extent as to prevent the keystone from being thoroughly incorporated with it. And at this stage of the work the rolling must be thorough so that the surfacing is compacted to a smooth, solid layer.

The second treatment of bituminous material, applied to the amount of ½ to ¾ of a gal. per sq. yd. is followed by a cover of stone chips of varying size depending upon the hardness of the stone and also upon the size of the choke stone used. Thus, with hard stone, 1½ to 2½ in. in size with ⅝ to 1 in. keystone, the cover stone should be ⅜ to ⅝ in. and correspondingly different sizes of cover stone should be used as described under the two methods of construction.

### Final Appearance of the Surface

A bituminous macadam surface should not have a heavy mat of bitumen, but on the contrary should have a mosiac appearance due to the coarse stone, and when bituminous macadams have this appearance they quite generally remain free from any corrugations. A bituminous macadam pavement requires very close attention to detail in its construction and when the essential details are followed carefully, the resulting surface has excellent riding qualities and the maintenance expense will be low if a proper base has been used.

### Maintenance Methods

The maintenance of a bituminous macadam pavement generally takes the form of a surface treatment of bituminous material applied at varying intervals depending upon the conditions. These treatments are covered with coarse stone chips thoroughly rolled. Sometimes patching of the surface is necessary before surface treatment and at others scarifying, re-shaping and the addition of new surfacing materials are given. Maintenance methods also include a method which involves the use of a light application of cold bitumen followed by the use of a heavy road plane which cuts down the high spots and fills the low spots in the surface. The excess surfacing material is carried to the shoulders and thus a bituminous surface is gradually built up on the shoulders.

### Construction Costs

The construction costs vary greatly, but for a 2½ to 3 in. depth they may be $9,000 to $17,000 per mile for an 18-foot width.

### Maintenance Costs

Some bituminous macadams run as low as $150 per mile per year with an average of $300 per mile and an average for all types including old bituminous macadams may be stated roughly at $350 per year.

### Service

When well constructed, the bituminous macadam pavement is smooth riding, and capable of carrying heavy, high speed traffic. For average conditions, bituminous macadam is economical for 1,000 to 2,000 vehicles per day. Much depends upon load carrying capacity of the subgrade and foundation courses. High wheel loads may be carried when the foundation is good.

## The Bituminous Concrete Types

There are a number of different types of bituminous concrete which may be roughly classified into:

1. Hot mix, coarse-graded bituminous concrete
2. Hot mix, fine-graded bituminous concrete
3. Mixed macadam
4. Cold mixed bituminous concretes
5. Miscellaneous types

### General Discussion

The bituminous concretes form a very high type of wearing surface but they should be laid on an exceptionally good base in order that their full service value may be realized. Their construction costs vary widely depending upon a number of conditions but in general they probably exceed the cost of bituminous macadam of equal thickness. Their traffic capacity averages somewhat higher than that of bituminous macadam, although in this they vary widely. Their maintenance costs will generally be found to be lower than bituminous macadam. In bituminous concrete mixtures a good grade of stone should be used with a per cent of wear of not less than 6.0. The gradation requirements for the stone for the above types run approximately as follows:

Bituminous concrete coarse aggregate type, base course, 1/4 to 1 1/4 in., 1/4 to 2 1/2 in. or 1 1/4 to 2 1/2 in.

For the surface coarse the size generally used is 1/4 to 1 1/4 in.

For the fine graded bituminous concrete, hot mixed type, 1/4 to 3/4 in. material or 1/4 to 1 1/2 in. is ordinarily used with 1/4 to 1/2 in. chips.

For the so-called "mixed macadam" which is essentially the same as coarse graded bituminous concrete, such as used in black base work, the size required is as follows:

| | |
|---|---|
| Passing 2 in. screen | 95% |
| Passing 1 in. screen | 25 to 75% |
| Passing 1/4 in. screen | 0% |

This material is combined with asphaltic cement to give the following proportions:

| | |
|---|---|
| Passing 2 in., retained on 1 in. screen | 20 to 45% |
| Passing 1 in., retained on 1/4 in. screen | 25 to 45% |
| Passing 1/4 in. | 25 to 35% |
| Asphaltic cement | 4 to 6% |

Cold mixed bituminous concretes are typified by patented materials such as Amiesite, "Tarmac," "Tarvia-Lithic," etc. The oldest of these mixes is Amiesite which is generally laid in 2 courses to a total compacted thickness of 2 inches, 1 1/2 inches in the base course and 1/2 inch in the top course. The following are typical limitations:

| Materials | Bottom layer Maximum percentage | Top layer Maximum percentage |
|---|---|---|
| Broken rock ..... | 86 to 92 | 83 to 90 |
| Liquifer ......... | 0.4 to 1.0 | 0.4 to 1.0 |
| Asphalt cement .. | 4 to 6 | 5 to 7 |
| Hydrated lime ... | 0.5 to 1.0 | 0.5 to 1.0 |
| Mineral filler .... | 0 to 6 | 0 to 8 |

Mixtures using tars may employ 3/4 in. crushed stone and sand in the proportions of one part sand and 3 parts of stone and combined with these aggregates there is generally employed a type of cold patch tar in the proportions of 12 gallons of tar to 27 feet of total aggregate. The size of stone desired passes a 1 1/4 in. screen and is retained on a 5/8 in. screen. Liquid asphalt is used in the same way as tar.

The proper manufacture of these various forms of bituminous concrete is a specialized subject as is also their proper laying. They are intended for use under comparatively heavy traffic.

## Conclusion

Those interested in the types of bituminous materials best suited for the various classes of bituminous pavements, should refer to the specifications for these materials issued by the Federal Specifications Board, Washington, D. C., as United States Government Master Specifications. The various grades of tars and asphalts for the different kinds of bituminous work are adequately described in these specifications.

In conclusion, it is believed that each of the types of pavement utilizing crushed stone has its particular place in the development of secondary highways. It may be that if a particular type is just able to serve today's traffic, its capacity will soon be outgrown, but by using the stage construction method almost its entire value is saved, for merely by an addition to its surface of a more adequate type it again becomes a useful, economical highway. By properly suiting road types to traffic needs the greatest possible mileage will be made available to the traveling public quickly and economically.

It will be wise to assume that there will be some increase in traffic and at least the possibility of such an increase should be fully taken into account.

# Committee on Accident Prevention Discusses Plans for Year

By H. E. Rodes, *Chairman,*
*Franklin Limestone Co., Nashville, Tenn.*

YOUR Committee on Accident Prevention met at Cincinnati May 23rd. Its purpose was to draw up a plan for accident prevention work by the Association, which plan is to be submitted to the Board of Directors in July for their approval.

At the request of the Chairman, an engineer from the Independence Bureau, of Philadelphia, Pa., an engineering firm specializing in Accident Prevention and Fire Prevention, met with the Committee.

A general discussion of the science of Accident Prevention, the results obtained and obtainable, the methods to be used, and the part the National Crushed Stone Association, operating through this Committee and through the Secretary, can play in reducing the heavy casualty cost in the crushed stone industry brought out certain facts and led to certain conclusions. These are covered very briefly in this discussion.

### Facts Brought Out

During the last few years a considerable number of quarries have practically eliminated accidents that involve the loss of time. Enough quarries have done this and over a long enough period to prove not only that accidents can be practically eliminated, but that any quarry can do it.

Most of the industry has taken care of the more obvious things but nevertheless accidents continue. Few are doing really effective work in prevention and the total of preventable accidents in the industry is very large. Just what saving is possible can only be guessed at. It is certainly conservative, however, to say that only moderately effective work by the whole industry would easily justify a cut of 50% in casualty insurance rates. As a matter of fact, the General Crushed Stone Company has saved more than this. Others have gotten similar results. Every quarry can do it.

Most of the accidents are coming from mild hazards. In the end these are far worse than the occasional serious hazard, because mild hazards exist everywhere and affect every employe. This means that accident prevention must be not only an intimate concern of each quarry executive but each and every employe must acquire skill in working safely.

The chief reason why so few quarries have reached a high standard in eliminating accidents is that their managements are only passively interested in accident prevention. Passive interest isn't enough. Every management must apply the same sort of intelligent forceful effort to the elimination of accidents that it does to operation. If it does this, satisfactory results are assured.

### The Function of Your Committee

Your Committee on Accident Prevention cannot make detailed studies of conditions at each quarry. To be of service it must somehow get quarry managements interested to a point where they push their accident prevention work hard enough to make it effective. The entire campaign of the Committee will be based on that premise. Fortunately, the facts as to the benefits of accident elimination once fully understood are very convincing, so that if the work of the Committee is done well, good results should be secured.

### Savings in Eliminating Accidents

We cannot emphasize too strongly that it pays to eliminate accidents. And we mean eliminate—not just hold down to a not very serious level. The direct cost of accidents is only a small part of it. The hidden costs to be saved, and, more important still, the profits that can be made through the measures necessary to eliminate accidents are the main things. Take a typical case. A quarry employing about 60 men was running with an average total annual lost time from accidents of about 250 man days a year. In direct cost this didn't look large. But the manager got interested and drove hard for safety. In two years time, accidents had practically been eliminated. He states that the better supervision, better spirit among employes, and better standards of work generally resulting from the drive to eliminate accidents yield large profits that cannot be measured exactly, but he knows they are very important. And the experience of all who have done really good accident prevention work is similar. Accident prevention pays big dividends.

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# The Business Man and His Organization

By William Butterworth,

*President, Chamber of Commerce of the United States*

THIS Annual Meeting has addressed itself to the task of identifying and appaising the growing responsibilities of business and business men. This is most appropriate, for we are all aware of the extent and the rapidity of changes in our business life in these restless days when all progressive business men are seeking to make their concerns responsible to new demands and new conditions.

Tradition is having a hard time. The fact that a thing "always has been" done in a particular way is no longer accepted as a compelling reason why it should continue to be done that way. The business man who was labeled a "theorist" a while ago when he suggested new business line-ups, is today accepted as very much of "a realist." Science and business, teamed together, are making commonplaces of the miraculous. And the business man who would succeed today must step up his thinking and his enterprises to the requirements of these very exacting times.

It is worth while, accordingly, for us to consider the agencies which business men have created to enable them collectively to assay, accept and discharge their expanding responsibilities to their respective fields of business and to the public, and to take some account of the opportunities that lie before them to voice the collective aspirations of enlightened business men.

Broadly considered, a dual allegiance levies claim upon the business man. There is the claim of his community—his city, his home and the home of his enterprises. And there is the claim of his industry. The first is typified by the community organizations, the chamber of commerce; the second by the trade association.

* * * * * *

Let us now briefly consider the business man and his responsibility to his industry, and the trade association as the agency which affords him opportunity most fully to discharge that responsibility.

The trade association is both a laboratory and a forum. It offers an industry the facilities for intelligent research—the laying on the table for microscopic examination, so to speak, of productive and marketing and administrative methods and technique, as well as the searching out of possibilities which science and invention may offer for the progress and profit of the individual units and the industry as a whole. Moreover, the trade association regiments the industry, enabling it to form lines of offense and defense in the competition of industry with industry—a competition, in many respects, more vigorous and more intensive than the competition of unit with unit within the industry.

Valuable as is its service within the house of industry—setting things to the right about for the benefit and profit of the industry and its unit members—the trade association serves equally, if not even more, valuably as the agency through which an industry may foster proper relations with other business and industrial groups and with the public. Such a relation must be based on mutual confidence. Without it the hopes of an industry for progress and profit are largely vain, and intelligent business leadership is more and more realizing that the way to win such confidence is to deserve it.

Thus the trade association becomes a forum in which the enlightened opinion of an industry may, in effect, legislate for self-regulation and self-government by establishing sound standards of practice and conduct for the component units of the industry. This unity of opinion is a potent sanction. In a democracy—either political or industrial—there can be no stronger.

Measurable progress is being made toward self-regulation. More and more are we coming to understand that in and of ourselves, as business men, and through our organizations we can outlaw those practices and those abuses which are an outgrowth of unsound competition. These abuses are destructive of the real uses of competition and of its public value as a means of assuring a free flow and exchange of goods. Better than any other agency can our organizations of business men ban such practices and put the public upon notice of those who, for fancied temporary personal advantage, continue to masquerade under the guise of reputable business men to cloak practices which, in all other relations of life, are frowned upon by public opinion.

If it is most usefully and most fully to serve its industry, the trade association must be truly representative—representative in the widest possible degree of

[1] Presented at the Seventeenth Annual Meeting of the Chamber of Commerce of the United States, Washington, D. C., May 2, 1929.

the intelligence, enthusiasm and aspirations of the industry and not merely representative of dues-payers who mistakenly think that once they have joined a trade association and paid its fees the responsibilities of the industry need no longer interfere with their golf.

It is, moreover, a significant fact that many of the problems with which industry, today, must wrestle—problems of standards of practice as well as many internal problems of management, production and marketing—are traceable to an archaic, Alexander Selkirk complex of certain business men who cannot disabuse their minds of the fallacy that they are all-sufficient "monarchs of all they survey" when, in fact, no man, today, is so big; no man is so much the master of his business fate that he can go ahead alone, afoot and across lots, regardless of what the rest of the business world is doing! Fortunately, however, for both public and business their tribe is decreasing.

The objectives thus briefly set forth are eminently worth while. Their achievement requires, first of all, a lively and continuing interest on the part of each and every individual representing each and every unit within the industry, for the success of a trade association depends upon the breadth of vision of the leaders of the industry and upon the harmonious cooperation—the will to pull together—on the part of all its constituents.

We have long since discovered that snap judgment examination of problems results in superficial action. Such action is foredoomed to failure. In an increasing degree are we recognizing that it is absolutely necessary that we individually apply ourselves with diligence to the analysis and solution of the problems common to our enterprises. Lincoln said that "nothing worth while is lost by taking time enough to do it right," and when he said it he laid down a perfectly good trade association formula.

Yet at times the viewpoint is advanced that organization tends to dull the fine edge of individual initiative. Not at all. Our organizations are voluntary enlistments, a coordination of individual initiative—a coordination which gives to the conclusions of alert and intelligent and courageous business thought the momentum and driving power of united action.

The value of individual participation—not in terms of fees and dollars and cents, but in the larger terms of unselfish contribution of thought and experience and enthusiasm for common interests, can not be too strongly emphasized. The public respect for our organizations of business men—our chambers of commerce and trade associations—rests upon the democracy of our methods. Never should they become the methods of autocracy. The views of our business organizations wield their influence in shaping public policies intimately affecting both public and business, because they are the views—not of the few, no matter how towering their stature or how eminent their ability—but the views of the many, projected upon the background of public interest.

Our organization objectives, moreover, should never be picayune inconsequentials but always those dominant concerns that are to the fore in their effect on the welfare of our communities and our business and industrial enterprises. These concerns and these issues—in a very intimate and far-reaching degree—affect the welfare of every citizen in the land. To chart a proper course for our business organizations is thus a challenge to the best efforts of every one of us.

In going about the country as it has been my privilege during the past year, observing at close range the character and work of many of our business organizations, I have been profoundly impressed by the practical acceptance in community after community and in association after association of the ideas I have endeavored to set forth here this morning. It has been an inspiring experience to observe men of great attainment in the business world—and oftentimes under circumstances that involve a very real sacrifice of personal pursuits—cheerfully and enthusiastically take their parts and places in chamber of commerce and trade association activities. Their inspiration has been and is the real opportunity these agencies afford them to make personal contributions to public welfare with no thought of personal gain or aggrandizement. Thus the spirit we saw so bounteously manifest during the war years, when a national emergency called forth the highest sort of disinterested volunteer service in a high cause, is carrying on.

* * * * * *

May I now, as a final word, invite your attention to a recent utterance of President Hoover, who is a firm believer and a staunch advocate of business teamwork, broadly conceived and directed toward proper objectives.

"In the past quarter of a century," says Mr. Hoover, "we have evolved a higher sense of organized cooperation than has ever been known before. We have many examples of this in the enormous growth of associational activities . . . They represent every phase of our national life on the economic and on the welfare side. . . . They have become part of the very fabric

(*Continued on page* 20)

# The National Safety Competition of 1928[1]

By W. W. Adams,
*Supervising Statistician, U. S. Bureau of Mines*

THE results of the fourth annual safety contest, known as the National Safety Competition, conducted by the United States Bureau of Mines are herein announced. A bronze trophy, "Sentinels of Safety," the gift of the Explosives Engineer magazine, has been awarded to the leading mine in each of the five groups into which the mines and quarries that participated in the contest were arranged. These five groups were: anthracite mines, bituminous coal mines, metal mines nonmetallic-mineral mines, and quarries and open-pit mines. The leading plant in each group was the mine whose employees lost the smallest number of days from accidents in proportion to the total number of man hours worked. Where two or more mines operated without a lost-time accident, the winner was adjudged to be the plant which operated the largest number of man hours during the year.

The contest was based upon reports of accidents and exposure sent by the competing companies to the Bureau of Mines. Records of the five leading companies in each group were made known to a Committee of Award, consisting of the following seven members: H. Foster Bain, Secretary of the American Institute of Mining and Metallurgical Engineers; James F. Callbreath, Secretary of the American Mining Congress; W. H. Cameron, Managing Director of the National Safety Council; H. L. Gandy, Secretary of the National Coal Association; A. T. Goldbeck, Director of the Engineering Bureau of the National Crushed Stone Association; William Green, President of the American Federation of Labor; and A. J. R. Curtis, Assistant to the General Manager of the Portland Cement Association. Members of the Committee voted for the winning company in each group in accordance with the rules governing the contest. A majority vote prevailed.

Eligibility to enroll in the contest was limited to mines employing at least fifty men underground and to quarries or surface mines employing at least twenty-five men inside the pit. However, the contest covered employees in surface shops and yards connected with the underground or quarry operations. In some cases the number of employees fell below the minimum permissible under the rules and this fact automatically eliminated the plants as contenders for a trophy. For statistical purposes, however, the records for these plants are included in the accompanying tables. Still other plants were enrolled at the beginning of the contest period had to discontinue as contestants either because mining operations ceased or for some other reason.

When the contest period closed it was found that the mines and quarries that had participated in the competition, including those which had ceased to be formal contenders for a trophy, numbered 284. Men employed at these plants worked 91,746,707 man hours and received 6,109 lost-time injuries which resulted in a loss of time or period of disability equal to 900,182 man days. The accidents included 110 deaths, 1 permanent total disability, 121 permanent partial disabilities, and 5,877 temporary lost-time injuries. A lost-time injury is defined as an injury that disables an employee for more than the remainder of the day on which the accident occurred. All days of disability were counted, whether they were Sundays, holidays, or days on which the plant was idle.

## Scope of the Competition

The scope of the National Safety Competition of 1928 is indicated by the following figures:

| | *Hours* | *Accidents* | *Lost Days* |
|---|---|---|---|
| Anthracite mines | 22,844,885 | 2,013 | 249,421 |
| Bit. coal mines | 29,308,391 | 2,490 | 365,513 |
| Metal mines | 16,518,598 | 861 | 157,103 |
| Nonmetallic-mineral mines | 2,922,799 | 154 | 23,193 |
| Quarries and open-pit mines | 20,152,034 | 591 | 104,952 |
| Total, 1928 284 | 91,746,707 | 6,109 | 900,182 |
| 1927 256 | 91,919,812 | 6,645 | 866,021 |
| 1926 256 | 95,055,815 | 7,313 | 799,493 |
| 1925 210 | 68,418,283 | 6,848 | 580,895 |

The mines and quarries that participated in the contest were situated in 35 States, as follows:

| | | |
|---|---|---|
| Alabama | Maryland | Pennsylvania |
| Arizona | Massachusetts | South Dakota |
| California | Michigan | Tennessee |
| Colorado | Minnesota | Texas |
| Connecticut | Missouri | Utah |
| Florida | Montana | Vermont |
| Illinois | Nebraska | Virginia |
| Indiana | New Jersey | Washington |
| Iowa | New York | Wisconsin |
| Kansas | New Mexico | West Virginia |
| Kentucky | Ohio | Wyoming |
| Louisiana | Oklahoma | |

[1] Printed by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright).

The accident-frequency rate per million man hours and the accident-severity rate per thousand man hours for each group are indicated below:

| | *Frequency rate* | *Severity rate* |
|---|---|---|
| Anthracite mines | 88.1 | 10.918 |
| Bituminous coal mines | 85.0 | 12.471 |
| Metal mines | 52.1 | 9.511 |
| Nonmetallic mineral mines | 52.7 | 7.935 |
| Quarries and open-pit mines | 29.3 | 5.208 |
| All mines | 66.6 | 9.812 |

## 34 Plants in Quarry Group Make Perfect Record

Of the 284 mines and quarries in all five groups in the contest 42 plants were operated during the year without a single lost-time accident. The 284 plants represented 91,746,707 man hours of exposure. Thirty-four of the 129 plants in the quarry and open-pit mine group had no lost-time accidents. Four of the 48 metal mines were operated without an accident. Three of the 19 mines in the nonmetallic mine group also had no lost-time accidents.

A comparison of the results of the contest of 1928 with those of the contest of 1927 shows that the anthracite group reduced its accident-frequency rate in 1928 but suffered a slight increase in its accident-severity rate. The bituminous-coal group reduced both its frequency rate and its severity rate. The metal-mine group lowered its frequency rate but had small increase in its severity rate, the latter being due to an increased fatality rate. The nonmetallic-mineral mine group had increases in both frequency and severity rates. The quarry and open-pit mine group had a lower frequency rate but a higher severity rate. The combined rates for all five groups showed a reduction of 8 per cent in frequency and an increase of 4 per cent in severity. To recapitulate: The net improvement in the accident-frequency rate for the contest as a whole should be credited to the anthracite, bituminous, metal, and quarry groups, and the small net increase in the accident-severity rate for the contest as a whole must be charged against the anthracite, metal, nonmetal, and quarry groups. A notable reduction was effected in the accident-severity rate of the bituminous-coal mine group.

The accident-frequency rate indicates the number of accidents (including fatalities, and permanent and temporary lost-time injuries) per million man hours of exposure or employment of all employees at the mine. The accident-severity rate indicates the number of lost days, or period of disability, represented by these same accidents per thousand man hours of exposure. To determine the lost-time equivalent of all accidents considered together, it is explained that each fatality or permanent total disability represents 6,000 lost days; each permanent partial disability represents a certain percentage of 6,000 days, depending upon the part of the body affected and nature of the injury, as shown in the scale recommended by the Association of Industrial Accident Boards and Commissions; and each temporary disability is rated according to the actual number of days of disability of the injured employee, except that the day on which the accident occurred is not counted.

The five winners of the National Safety Competition of 1928, to each of whom was awarded a bronze trophy, the "Sentinels of Safety," were as follows:

### Winner in Quarry Group

*Editor's Note: Due to lack of space, only the winner in the quarry group is given.*

Quarries and open-pits: The Wakefield open-pit iron-ore mine at Wakefield, Mich., operated by the Wakefield Iron Co. This open-pit mine worked 283,680 man hours in 1928 and had no lost-time accidents.

The following figures show the accident-severity rates per thousand man hours of exposure for the five winning companies and for each of the five groups:

| | *Winning company* | *Group average* |
|---|---|---|
| Anthracite mines | 0.637 | 10.918 |
| Bituminous coal mines | .053 | 12.471 |
| Metal mines | .000 | 9.511 |
| Nonmetallic mines | .000 | 7.935 |
| Quarries and open-pit mines | .000 | 5.208 |
| Average | .159 | 9.812 |

The accident-frequency rates per thousand man hours of exposure for the winning plants and for each of the groups were:

| | *Winning company* | *Group average* |
|---|---|---|
| Anthracite mines | 52.9 | 88.1 |
| Bituminous coal mines | 7.2 | 85.0 |
| Metal mines | 0.0 | 52.1 |
| Nonmetallic mines | 0.0 | 52.7 |
| Quarries and open-pit mines | 0.0 | 29.3 |
| | 13.9 | 66.6 |

The following figures show the average length of disability resulting from injuries of a temporary nature, also the average number of days of disability per injury, including deaths and permanent and temporary injuries, when weighted in the manner previously described:

| | *Temporary injuries (days)* | *All fatal and nonfatal injuries (days)* |
|---|---|---|
| Anthracite mines | 20.7 | 123.9 |
| Bituminous coal mines | 26.2 | 146.8 |
| Metal mines | 17.7 | 182.5 |
| Nonmetallic-mineral mines | 15.7 | 150.6 |
| Quarries and open-pit mines | 20.0 | 177.6 |
| | 22.3 | 147.4 |

(*Continued on page* 20)

*Editor's Note: Due to lack of space, only the table covering the quarry group is given.*

GROUP 5.—ACCIDENT DATA FOR CERTAIN *QUARRIES AND OPEN-PIT MINES* IN 1928 [1]

| Code No. | | Hours worked | Number of accidents | | | | | Number of days lost | | | | | Frequency[2] rate | Severity[2] rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fatal | P. T. | P. P. | Temporary | Total | Fatal | P. T. | P. P. | Temporary | Total | | |
| 3 | 1 | 283,680 | | | | | | | | | | | .000 | .000 |
| 4 | 2 | 228,048 | | | | | | | | | | | .000 | .000 |
| 5 | 3 | 223,801 | | | | | | | | | | | .000 | .000 |
| 6 | 4 | 212,921 | | | | | | | | | | | .000 | .000 |
| 7 | 5 | 208,650 | | | | | | | | | | | .000 | .000 |
| 8 | 6 | 178,188 | | | | | | | | | | | .000 | .000 |
| 9 | 7 | 166,768 | | | | | | | | | | | .000 | .000 |
| 10 | 8 | 159,206 | | | | | | | | | | | .000 | .000 |
| 11 | 9 | 143,425 | | | | | | | | | | | .000 | .000 |
| 12 | 10 | 139,081 | | | | | | | | | | | .000 | .000 |
| 13 | 11 | 135,055 | | | | | | | | | | | .000 | .000 |
| 14 | 12 | 133,769 | | | | | | | | | | | .000 | .000 |
| 15 | 13 | 132,707 | | | | | | | | | | | .000 | .000 |
| 16 | 14 | 122,466 | | | | | | | | | | | .000 | .000 |
| 19 | 15 | 114,600 | | | | | | | | | | | .000 | .000 |
| 20 | 16 | 111,698 | | | | | | | | | | | .000 | .000 |
| 21 | 17 | 109,350 | | | | | | | | | | | .000 | .000 |
| 23 | 18 | 104,326 | | | | | | | | | | | .000 | .000 |
| 26 | 19 | 92,208 | | | | | | | | | | | .000 | .000 |
| 27 | 20 | 90,383 | | | | | | | | | | | .000 | .000 |
| 28 | 21 | 86,263 | | | | | | | | | | | .000 | .000 |
| 30 | 22 | 83,793 | | | | | | | | | | | .000 | .000 |
| 31 | 23 | 83,294 | | | | | | | | | | | .000 | .000 |
| 32 | 24 | 76,156 | | | | | | | | | | | .000 | .000 |
| 33 | 25 | 75,606 | | | | | | | | | | | .000 | .000 |
| 34 | 26 | 73,834 | | | | | | | | | | | .000 | .000 |
| 35 | 27 | 69,981 | | | | | | | | | | | .000 | .000 |
| 36 | 28 | 64,414 | | | | | | | | | | | .000 | .000 |
| 37 | 29 | 60,071 | | | | | | | | | | | .000 | .000 |
| 38 | 30 | 59,224 | | | | | | | | | | | .000 | .000 |
| 39 | 31 | 56,958 | | | | | | | | | | | .000 | .000 |
| 40 | 32 | 49,711 | | | | | | | | | | | .000 | .000 |
| 41 | 33 | 48,025 | | | | | | | | | | | .000 | .000 |
| 42 | 34 | 27,560 | | | | | | | | | | | .000 | .000 |
| 43 | 35 | 69,115 | | | | 1 | 1 | | | | 1 | 1 | 14.469 | .014 |
| 44 | 36 | 151,222 | | | | 1 | 1 | | | | 6 | 6 | 6.613 | .040 |
| 45 | 37 | 74,172 | | | | 1 | 1 | | | | 3 | 3 | 13.482 | .040 |
| 47 | 38 | 624,218 | | | | 1 | 1 | | | | 30 | 30 | 1.602 | .048 |
| 48 | 39 | 128,578 | | | | 1 | 1 | | | | 7 | 7 | 7.777 | .054 |
| 50 | 40 | 196,179 | | | | 1 | 1 | | | | 11 | 11 | 5.097 | .056 |
| 51 | 41 | 209,686 | | | | 5 | 5 | | | | 14 | 14 | 23.845 | .067 |
| 52 | 42 | 279,419 | | | | 2 | 2 | | | | 19 | 19 | 7.158 | .068 |
| 53 | 43 | 186,260 | | | | 1 | 1 | | | | 13 | 13 | 5.369 | .070 |
| 54 | 44 | 54,415 | | | | 1 | 1 | | | | 4 | 4 | 18.377 | .074 |
| 55 | 45 | 107,038 | | | | 1 | 1 | | | | 8 | 8 | 9.342 | .075 |
| 56 | 46 | 273,690 | | | | 1 | 1 | | | | 23 | 23 | 3.654 | .084 |
| 57 | 47 | 138,464 | | | | 5 | 5 | | | | 14 | 14 | 36.110 | .101 |
| 58 | 48 | 56,000 | | | | 2 | 2 | | | | 6 | 6 | 35.714 | .107 |
| 60 | 49 | 225,097 | | | | 1 | 1 | | | | 29 | 29 | 4.443 | .129 |
| 64 | 50 | 74,915 | | | | 1 | 1 | | | | 11 | 11 | 13.348 | .147 |
| 65 | 51 | 194,446 | | | | 2 | 2 | | | | 32 | 32 | 10.286 | .165 |
| 66 | 52 | 131,686 | | | | 3 | 3 | | | | 24 | 24 | 22.781 | .182 |
| 68 | 53 | 120,451 | | | | 2 | 2 | | | | 24 | 24 | 16.604 | .199 |
| 69 | 54 | 216,849 | | | | 1 | 1 | | | | 45 | 45 | 4.612 | .208 |
| 70 | 55 | 213,802 | | | | 4 | 4 | | | | 50 | 50 | 18.709 | .234 |
| 71 | 56 | 77,474 | | | | 2 | 2 | | | | 19 | 19 | 25.815 | .245 |
| 72 | 57 | 85,457 | | | | 1 | 1 | | | | 21 | 21 | 11.702 | .246 |
| 73 | 58 | 129,944 | | | | 8 | 8 | | | | 33 | 33 | 61.565 | .254 |
| 74 | 59 | 90,000 | | | | 2 | 2 | | | | 23 | 23 | 22.222 | .256 |
| 75 | 60 | 178,301 | | | | 3 | 3 | | | | 48 | 48 | 16.825 | .269 |
| 77 | 61 | 124,911 | | | | 2 | 2 | | | | 36 | 36 | 16.011 | .288 |
| 78 | 62 | 92,568 | | | | 2 | 2 | | | | 27 | 27 | 21.606 | .292 |
| 79 | 63 | 263,591 | | | | 13 | 13 | | | | 78 | 78 | 49.319 | .296 |
| 80 | 64 | 79,935 | | | | 5 | 5 | | | | 24 | 24 | 62.551 | .300 |
| 81 | 65 | 76,000 | | | | 2 | 2 | | | | 23 | 23 | 26.316 | .303 |
| 83 | 66 | 104,352 | | | | 2 | 2 | | | | 34 | 34 | 19.166 | .326 |
| 85 | 67 | 102,408 | | | | 2 | 2 | | | | 34 | 34 | 19.530 | .332 |
| 89 | 68 | 173,390 | | | | 3 | 3 | | | | 68 | 68 | 17.302 | .392 |
| 91 | 69 | 71,094 | | | | 3 | 3 | | | | 29 | 29 | 42.198 | .408 |

GROUP 5.—ACCIDENT DATA FOR CERTAIN *QUARRIES AND OPEN-PIT MINES* IN 1928 [1]

| Code No. | | Hours worked | Number of accidents | | | | | Number of days lost | | | | | Frequency[2] rate | Severity[2] rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fatal | P. T. | P. P. | Temporary | Total | Fatal | P. T. | P. P. | Temporary | Total | | |
| 94 | 70 | 67,454 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 31 | 31 | 44.475 | .460 |
| 95 | 71 | 215,787 | ...... | ...... | ...... | 6 | 6 | ...... | ...... | ...... | 101 | 101 | 27.805 | .468 |
| 96 | 72 | 181,062 | ...... | ...... | ...... | 5 | 5 | ...... | ...... | ...... | 89 | 89 | 27.615 | .492 |
| 97 | 73 | 107,482 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 54 | 54 | 27.912 | .502 |
| 98 | 74 | 248,862 | ...... | ...... | ...... | 11 | 11 | ...... | ...... | ...... | 133 | 133 | 44.201 | .534 |
| 99 | 75 | 150,364 | ...... | ...... | ...... | 9 | 9 | ...... | ...... | ...... | 81 | 81 | 59.855 | .539 |
| 100 | 76 | 364,377 | ...... | ...... | ...... | 2 | 2 | ...... | ...... | ...... | 209 | 209 | 5.489 | .574 |
| 101 | 77 | 124,774 | ...... | ...... | ...... | 11 | 11 | ...... | ...... | ...... | 72 | 72 | 88.159 | .577 |
| 103 | 78 | 171,116 | ...... | ...... | ...... | 5 | 5 | ...... | ...... | ...... | 101 | 101 | 29.220 | .590 |
| 106 | 79 | 156,960 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 110 | 110 | 19.113 | .701 |
| 109 | 80 | 145,840 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 107 | 107 | 20.570 | .734 |
| 110 | 81 | 150,544 | ...... | ...... | ...... | 10 | 10 | ...... | ...... | ...... | 111 | 111 | 66.426 | .737 |
| 111 | 82 | 107,775 | ...... | ...... | ...... | 2 | 2 | ...... | ...... | ...... | 83 | 83 | 18.557 | .770 |
| 114 | 83 | 198,289 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 163 | 163 | 15.129 | .822 |
| 116 | 84 | 164,997 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 139 | 139 | 18.182 | .842 |
| 118 | 85 | 72,188 | ...... | ...... | ...... | 2 | 2 | ...... | ...... | ...... | 62 | 62 | 27.705 | .859 |
| 120 | 86 | 63,207 | ...... | ...... | ...... | 4 | 4 | ...... | ...... | ...... | 61 | 61 | 63.284 | .965 |
| 121 | 87 | 110,736 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 110 | 110 | 27.091 | .993 |
| 122 | 88 | 135,565 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 137 | 137 | 22.130 | 1.011 |
| 125 | 89 | 77,445 | ...... | ...... | ...... | 15 | 15 | ...... | ...... | ...... | 85 | 85 | 193.686 | 1.098 |
| 126 | 90 | 82,636 | ...... | ...... | ...... | 2 | 2 | ...... | ...... | ...... | 91 | 91 | 24.203 | 1.101 |
| 129 | 91 | 145,874 | ...... | ...... | ...... | 1 | 1 | ...... | ...... | ...... | 166 | 166 | 6.855 | 1.138 |
| 133 | 92 | 184,944 | ...... | ...... | ...... | 7 | 7 | ...... | ...... | ...... | 223 | 223 | 37.849 | 1.206 |
| 137 | 93 | 202,800 | ...... | ...... | ...... | 26 | 26 | ...... | ...... | ...... | 264 | 264 | 128.205 | 1.302 |
| 141 | 94 | 52,230 | ...... | ...... | ...... | 4 | 4 | ...... | ...... | ...... | 70 | 70 | 76.584 | 1.340 |
| 142 | 95 | 218,047 | ...... | ...... | ...... | 12 | 12 | ...... | ...... | ...... | 293 | 293 | 55.034 | 1.344 |
| 144 | 96 | 89,234 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 121 | 121 | 33.619 | 1.356 |
| 146 | 97 | 136,488 | ...... | ...... | ...... | 6 | 6 | ...... | ...... | ...... | 193 | 193 | 43.960 | 1.414 |
| 153 | 98 | 118,877 | ...... | ...... | ...... | 5 | 5 | ...... | ...... | ...... | 178 | 178 | 42.060 | 1.497 |
| 154 | 99 | 308,174 | ...... | ...... | ...... | 22 | 22 | ...... | ...... | ...... | 465 | 465 | 71.388 | 1.509 |
| 155 | 100 | 115,584 | ...... | ...... | ...... | 7 | 7 | ...... | ...... | ...... | 177 | 177 | 60.562 | 1.531 |
| 156 | 101 | 36,091 | ...... | ...... | ...... | 1 | 1 | ...... | ...... | ...... | 56 | 56 | 27.708 | 1.552 |
| 159 | 102 | 56,798 | ...... | ...... | ...... | 2 | 2 | ...... | ...... | ...... | 108 | 108 | 35.213 | 1.901 |
| 160 | 103 | 281,993 | ...... | ...... | ...... | 21 | 21 | ...... | ...... | ...... | 559 | 559 | 74.470 | 1.982 |
| 167 | 104 | 105,722 | ...... | ...... | ...... | 18 | 18 | ...... | ...... | ...... | 237 | 237 | 170.258 | 2.242 |
| 174 | 105 | 71,853 | ...... | ...... | ...... | 7 | 7 | ...... | ...... | ...... | 182 | 182 | 97.421 | 2.533 |
| 177 | 106 | 42,198 | ...... | ...... | ...... | 3 | 3 | ...... | ...... | ...... | 111 | 111 | 71.093 | 2.630 |
| 181 | 107 | 90,299 | ...... | ...... | ...... | 1 | 1 | ...... | ...... | ...... | 271 | 271 | 11.074 | 3.001 |
| 183 | 108 | 113,501 | ...... | ...... | ...... | 21 | 21 | ...... | ...... | ...... | 354 | 354 | 185.020 | 3.119 |
| 185 | 109 | 93,082 | ...... | ...... | 1 | ...... | 1 | ...... | ...... | 300 | ...... | 300 | 10.743 | 3.223 |
| 187 | 110 | 161,045 | ...... | ...... | 1 | 15 | 16 | ...... | ...... | 300 | 223 | 523 | 99.351 | 3.248 |
| 195 | 111 | 71,630 | ...... | ...... | 1 | ...... | 1 | ...... | ...... | 300 | ...... | 300 | 13.961 | 4.188 |
| 199 | 112 | 71,241 | ...... | ...... | 1 | 7 | 8 | ...... | ...... | 300 | 51 | 351 | 112.295 | 4.927 |
| 201 | 113 | 1,254,500 | 1 | ...... | 1 | 23 | 25 | 6,000 | ...... | 600 | 236 | 6,836 | 19.928 | 5.449 |
| 208 | 114 | 70,225 | ...... | ...... | ...... | 10 | 10 | ...... | ...... | ...... | 511 | 511 | 142.399 | 7.277 |
| 216 | 115 | 218,603 | ...... | ...... | 1 | 6 | 7 | ...... | ...... | 1,800 | 407 | 2,207 | 32.022 | 10.096 |
| 218 | 116 | 366,912 | ...... | ...... | 1 | 50 | 51 | ...... | ...... | 3,000 | 802 | 3,802 | 138.998 | 10.362 |
| 219 | 117 | 172,378 | ...... | ...... | 1 | 1 | 2 | ...... | ...... | 1,800 | 2 | 1,802 | 11.602 | 10.454 |
| 223 | 118 | 579,289 | 1 | ...... | ...... | 18 | 19 | 6,000 | ...... | ...... | 252 | 6,252 | 32.799 | 10.793 |
| 234 | 119 | 493,329 | 1 | ...... | 1 | 20 | 22 | 6,000 | ...... | 600 | 267 | 6,867 | 44.595 | 13.920 |
| 242 | 120 | 219,417 | ...... | ...... | 1 | 18 | 19 | ...... | ...... | 3,600 | 190 | 3,790 | 86.593 | 17.273 |
| 249 | 121 | 438,133 | 1 | ...... | 1 | 9 | 11 | 6,000 | ...... | 3,000 | 227 | 9,227 | 25.107 | 21.060 |
| 254 | 122 | 240,000 | 1 | ...... | ...... | ...... | 1 | 6,000 | ...... | ...... | ...... | 6,000 | 4.167 | 25.000 |
| 265 | 123 | 178,990 | 1 | ...... | ...... | 5 | 6 | 6,000 | ...... | ...... | 54 | 6,054 | 33.521 | 33.823 |
| 271 | 124 | 147,964 | 1 | ...... | ...... | ...... | 1 | 6,000 | ...... | ...... | ...... | 6,000 | 6.758 | 40.550 |
| 276 | 125 | 132,533 | 1 | ...... | ...... | 8 | 9 | 6,000 | ...... | ...... | 272 | 6,272 | 67.908 | 47.324 |
| 277 | 126 | 126,897 | 1 | ...... | ...... | 6 | 7 | 6,000 | ...... | ...... | 334 | 6,334 | 55.163 | 49.914 |
| 280 | 127 | 101,964 | 1 | ...... | ...... | 1 | 2 | 6,000 | ...... | ...... | 47 | 6,047 | 19.615 | 59.305 |
| 281 | 128 | 106,569 | 1 | ...... | ...... | 4 | 5 | 6,000 | ...... | ...... | 384 | 6,384 | 46.918 | 59.905 |
| 284 | 129 | 58,819 | 2 | ...... | ...... | 3 | 5 | 12,000 | ...... | ...... | 64 | 12,064 | 85.007 | 205.104 |
| Totals and averages | | 20,152,034 | 13 | ...... | 11 | 567 | 591 | 78,000 | ...... | 15,600 | 11,352 | 104,952 | 29.327 | 5.208 |
| 1927 Totals and averages | | 26,030,768 | 15 | ...... | 16 | 842 | 873 | 90,000 | ...... | 18,900 | 14,510 | 123,410 | 33.537 | 4.741 |

[1] As the accident reports from mining companies are considered confidential by the Bureau of Mines, the identities of the mines to which this table relates are not revealed.

[2] Frequency rate indicates number of fatal, permanent, and other lost-time accidents per million man hours of exposure; severity rate indicates number of days lost from accidents per thousand man hours.

# The Crushed Stone Journal

Official Monthly Publication of the
NATIONAL CRUSHED STONE ASSOCIATION
Merchandise Building 1735 Fourteenth St., N. W.
WASHINGTON, D. C.

J. R. BOYD, Editor




## Thirty-four Plants Make Perfect Safety Record

THE results of the National Safety Competition of 1928 just recently made available and given elsewhere in this issue disclose at least one highly significant fact as regards accident prevention in the quarry industry—accidents can be *eliminated*. In the quarry and open pit mines group the results of the Competition show that out of the 129 plants entered in the contest 34 completed the year without a single lost time accident. This is certainly an amazing record and one of which the industry can well be proud.

All too frequently we hear the comment that the quarry industry is necessarily a hazardous one, in which accidents must inevitably occur. Such an attitude is assuredly refuted when 34 plants can operate for an entire year with no lost time accidents. The remarkable record established for 1928 is the result of a growing tendency on the part of the quarrying industry to earnestly and seriously endeavor to bring about a reduction of accidents. In this connection the figures for the Competition for 1926 and 1927 are interesting. In 1926 out of 118 plants entered in the quarry group 14 completed the year with no accidents while in 1927 out of 132 entered in the contest 29 finished with perfect records.

For the sake of emphasis therefore let us repeat that accidents in our industry can be very decidedly reduced and by giving the problem particular attention they can be eliminated.

The National Crushed Stone Association, through its Accident Prevention Committee, is giving this problem very serious attention. To be successful in its efforts will require the helpful cooperation of the entire membership. The Committee would more than welcome suggestions which should be directed to Chairman H. E. Rodes, Franklin Limestone Co., 612 10th Ave., N., Nashville, Tenn.

## Board of Directors will Meet in Atlantic City

FOLLOWING a custom of many years standing, the mid-year meeting of the Board of Directors of the National Crushed Stone Association will be held at the Ambassador Hotel, Atlantic City, on Friday and Saturday, July 26th and 27th, according to a call recently issued by President Wise. Many matters of vital importance to the Association will come up for action at this meeting, including reports of officers, progress reports of the various association committees, a detailed discussion of Association finances, the selection of the city and hotel for the 1930 annual convention and such other business as may properly come before the Board.

The reports of the Trade Practices Committee and the Committee on Accident Prevention should be of particular interest. The former, under the chairmanship of past-president Otho M. Graves, has held two meetings at which a tentative draft of resolutions covering bad practices in the crushed stone industry has been prepared. These tentative resolutions will be presented to the Board for their consideration and action. After the Board has approved these resolutions, it is hoped that arrangements can be made for a trade practice conference of the industry at the next annual meeting, at which time the entire industry will be given an opportunity to express itself as regards such resolutions as may tentatively be approved by the Board at its July meeting. The Accident Prevention Committee, under the chairmanship of H. E. Rodes, has held one

meeting at which a tentative plan for action was outlined and this plan will be submitted to the Board for its consideration and action.

Attendance at these mid-summer meetings of the Board in the past has been excellent and it is anticipated that the spirit of cooperation and self-sacrifice of the members of the Board in leaving their businesses to devote time and attention to the affairs of the Association will again produce a record breaking attendance at Atlantic City next month.

## Associate Membership Quota Nearly Filled

IT will be recalled that at the Cleveland Convention held last January the Manufacturers' Division voted to restrict the number of associate members to one hundred firms. The primary reason for imposing such restriction lies in the fact that if each associate member is to be extended the privilege (which he now enjoys) of exhibiting at the Manufacturers' Division Exposition held in conjunction with the annual convention, necessarily some limit must be placed upon the associate membership. This is, of course, premised on the supposition that the Exposition will continue to be held under the same roof as the convention, a feature which we believe contributes very largely to the interest and success of the Exposition.

Shortly after the Cleveland Convention, E. G. Lewis who was elected Chairman of the Manufacturers' Division at that time, undertook to launch an active and vigorous membership campaign to bring the number of associate members up to the quota of 100 by the time of the Board of Directors meeting which is held the latter part of July. That Chairman Lewis was setting for himself and the Vice-Chairmen and Board of Directors of the Division who have so ably assisted him, a difficult task can be appreciated when it is recalled that at the time of the Cleveland Convention the Manufacturers' Division included 83 firms. Chairman Lewis and his associates have made excellent progress in their membership drive as is attested to by the fact that since the Cleveland Convention twelve new firms have become members of the Division. There have been four resignations, giving a net gain of eight, which makes the total membership in the Division at the present time, 91 firms. Thus it will be seen that but 9 more members are necessary to fill the quota of 100. Chairman Lewis is confident that the quota will be completed before or shortly after the Board of Directors meeting in July and that he will be able to report a substantial waiting list by the time of the next annual meeting in January.

We wish to extend to the new members of the Manufacturers' Division a most cordial welcome and sincerely hope that their affiliation with the Association will prove both pleasant and profitable. Below are given the names of the companies who have joined the Manufacturers' Division since the Cleveland Convention.

American Steel & Wire Co., 208 S. LaSalle St., Chicago, Ill.

*Wire Rope*

Bethlehem Steel Co., Bethlehem, Pa.

*"Bethlehem" Pulverizer*

Cleveland Rock Drill Co., Cleveland Ohio

*"Cleveland" Rock Drills*

Consolidated Rock Products Co., 15 Park Row, New York City

*Rebuilt Machinery and Equipment*

Gardner-Denver Co., Box 1020, Denver, Colorado

*Pumps, Air Compressors, Rock Drills and Compressed Air Tools*

Thomas L. Gatke, 228 N. LaSalle St., Chicago, Ill.

*Manufacturer of Asbestos Friction Products*

Hercules Motors Corp., Canton, Ohio

*Manufacturers of heavy duty engines and power units for operation on gasoline, kerosene or natural gas*

Keystone Driller Co., Beaver Falls, Pa.

*Manufacturers—Keystone blast hole drills.*

Mack-International Motor Truck Corp., 42nd & Woodland Ave., Philadelphia, Pa.

*"Mack trucks are around whenever there is work to be found"*

McLanahan Stone Machine Co., Hollidaysburg, Pa.

*Crushers—Screen Washers*

Quaker City Rubber Co., Wissinoming, Philadelphia, Pa.

*Belting—Hose—Packing*

Ross Screen and Feeder Co., 247 Park Ave., New York City

*Screening, Feeding and Materials Handling Equipment*

### The National Safety Competition of 1928

(*Continued from page* 15)

The accompanying tables show the accident-frequency rates and the accident-severity rates for each mine and quarry that participated in the National Safety Competition of 1927. Though some of the companies did not maintain a sufficient number of employees during their period of operation to remain eligible for consideration in the award of the trophy, their records are, nevertheless, included in the tables.

Companies that operate mines or quarries not covered by the attached tables are invited to compare their accident rates with the rates presented to learn the positions which their mines or quarries would have attained if they had participated in the National Safety Competition. The Bureau of Mines would be glad to learn of any mine or quarry whose accident record was better than the leading plant in each of the five groups to which the attached tables relate.

### Committee on Accident Prevention Discusses Plans for Year

(*Continued from page* 11)

#### A Plea for Cooperation

Here is an opportunity for most of those in the industry to make important savings. Ask Messrs. Graves, Cartwright, Gucker or Earnshaw, or any one else who is doing effective accident prevention work. The evidence is too strong to doubt. Your Committee can help you share in these savings if you will cooperate. We will give liberally of our time and effort, but without your help our work will be wasted. We can lead you to the potential profits from the elimination of accidents, but you must do the detailed work that will enable you to turn those potential profits into black figures on the balance sheet.

#### The Committees Program

The exact form that the accident prevention work of this Committee will take must be determined by the Board of Directors. It will be sufficient for the present to say that we propose to act as a means of gathering and giving out helpful information on Accident Prevention. The Crushed Stone Journal will carry to you a series of articles of both general and special interest. We will attempt to give you a picture of the broader aspects of accident prevention work, its value, how to set about it, and what can be accomplished. And, of course, there will be a great amount of detail furnished by those who have made good records telling just how they did it. Again we ask your co-operation. With it we will get results and you will get profits; without it, we will all get exactly nowhere.

### The Business Man and His Organization

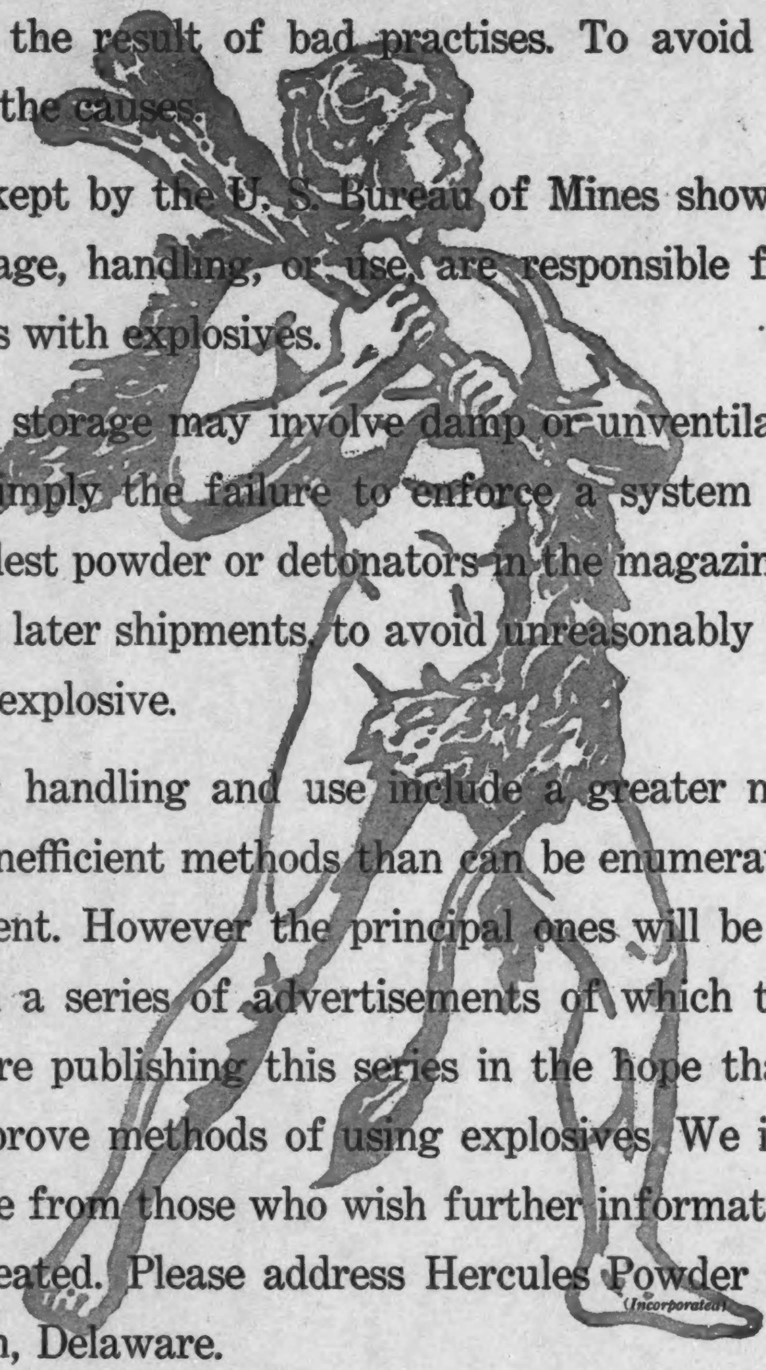
(*Continued from page* 13)

of American life. . . . Wherever these associations undertake high public purposes I wish to see active cooperation of government with them."

Here is opportunity! Here is a call to business leadership throughout the land! As we respond to that call, always mindful that "unto whom much has been given of him much will be required," will our works justify our professed faith in business teamwork through organizations of business men.

# IMPROVING BLASTING PRACTISE

ACCIDENTS are costly. Most of them are avoidable. They are usually the result of bad practises. To avoid them we must know the causes.




Records kept by the U. S. Bureau of Mines show that improper storage, handling, or use, are responsible for nearly all accidents with explosives.

Improper storage may involve damp or unventilated magazines, or simply the failure to enforce a system requiring that the oldest powder or detonators in the magazine shall be used before later shipments, to avoid unreasonably long storage of any explosive.

Improper handling and use include a greater number of unsafe or inefficient methods than can be enumerated in one advertisement. However the principal ones will be discussed in detail in a series of advertisements of which this is the first. We are publishing this series in the hope that it may help to improve methods of using explosives. We invite correspondence from those who wish further information on the subjects treated. Please address Hercules Powder Company, Wilmington, Delaware.

*COSTS CAN BE REDUCED BY BETTER STORING, HANDLING AND USE OF EXPLOSIVES*